

## SECTION 15A

### THERMAL INSULATION FOR MECHANICAL SYSTEMS

1. APPLICABLE PUBLICATIONS: The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designations only.

#### Federal Specifications (Fed. Spec.):

|                         |   |
|-------------------------|---|
| L-P-535E                | Plastic Sheet (Sheeting): Plastic Strip: Poly(Vinyl Chloride) and Poly(Vinyl Chloride-Vinyl Acetate) Rigid  |
| HH-B-100B               | Barrier Material Vapor (For Pipe, Duct and Equipment Thermal, Insulation)   |
| HH-I-551E               | Insulation Block and Boards, Thermal (Cellular Glass)   |
| HH-I-558B<br>& Am-3     | Insulation, Blocks, Boards, Blankets, Felts, Sleeving (Pipe and Tube Covering), and Pipe Fitting Covering, Thermal (Mineral Fiber, Industrial Type) |
| HH-I-573B<br>& Int Am-1 | Insulation, Thermal, (Flexible Unicellular Sheet and Pipe Covering)   |

#### Military Specifications (Mil. Spec.):

|                        |   |
|------------------------|---|
| MIL-A-3316B<br>& Am-6  | Adhesives, Fire-Resistant, Thermal Insulation                                   |
| MIL-B-19564B           | Bedding Compound, Thermal Insulation Pipe Covering                              |
| MIL-C-19565C           | Coating Compounds, Thermal Insulation, Fire- and Water-Resistant, Vapor-Barrier |
| MIL-C-20079F           | Cloth, Glass; Tape, Textile Glass; and Thread, Glass                            |
| MIL-A-24179A<br>& Am-2 | Adhesive, Flexible Unicellular-Plastic Thermal Insulation                       |
| MIL-I-24244B<br>& Am-1 | Insulation Material, with Special Corrosion Chloride, and Fluoride Requirements |

#### American Society for Testing and Materials (ASTM) Publications:

|           |   |
|-----------|---|
| B 209-82b | Aluminum and Aluminum-Alloy Sheet and Plate |
|-----------|---|

|          |   |
|----------|---|
| C 195-77 | Mineral Fiber Thermal Insulating Cement               |
| C 533-80 | Calcium Silicate Block and Pipe Thermal Insulation    |
| C 552-79 | Cellular Glass Block and Pipe Thermal Insulation      |
| E 84-81a | Surface Burning Characteristics of Building Materials |

1.4 Manufacturers Standardization Society of the Valve and Fittings Industry (MSS) Publication:

|       |  |
|-------|--|
| SP-69 | Pipe Hangers and Supports - Selection and Application (1976) |
|-------|--|

2. GENERAL REQUIREMENTS: General requirements for field-applied insulation are as stated herein. Factory-applied insulation is specified under the equipment, duct or piping to be insulated, as detailed in other sections of these specifications. Insulation materials required for use in conjunction with items furnished by the Government as listed in the SPECIAL PROVISIONS, shall be furnished and installed by the Contractor.

2.1 Identification of Material: Packages or standard containers of insulation, jacket material, cements, adhesives, and coatings delivered for use, and all samples required for approval shall have manufacturer's stamp or label attached giving the name of the manufacturer and brand, and a description of the material.

2.2 Verification of Dimensions and Conditions: The Contractor shall visit the premises to become thoroughly familiar with details of the work and working conditions, verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before starting the work.

2.3 Standard Products: Materials shall be the standard products of manufacturers regularly engaged in the manufacture of such products. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state.

3. SURFACE BURNING CHARACTERISTICS:

3.1 Requirements: Insulation materials, adhesives, coatings, and other accessories shall have surface burning characteristics as determined by ASTM E 84 not to exceed 75 for flame spread and 150 for smoke developed, except for the following materials:

- a. Nylon anchors for securing insulation to ducts or equipment.
- b. Factory premolded one-piece PVC fitting and valve covers.
- c. Weatherproof coating.

d. Asphaltic mastic.

e. Wood blocks and wood or cork dowels.

3.2 Flameproofing: Flameproofing treatments subject to deterioration due to the effect of moisture or high humidity are not acceptable.

#### 4. SUBMITTALS:

4.1 Insulation Data: Within 60 days of receipt of notice to proceed, and before starting installation of insulation materials, the Contractor shall submit to the Contracting Officer for approval a list of insulation data to be incorporated in the work. The data shall be descriptive information such as catalog cuts, diagrams, installation recommendations, and other information published by the manufacturer to demonstrate conformance to the specification. Materials furnished under this section of the specifications shall be submitted at one time. One copy of each data list will be returned and marked to indicate approval.

4.2 Display Sample Cutaway Sections: After approval of materials and prior to insulating any piping, a display shall be prepared of sample sections of piping insulated as specified in this section. Display sample sections will be inspected at the jobsite by the Contracting Officer. Approved display sample sections shall remain on display at the jobsite during the construction period. Upon completion of construction, the display sample sections will be returned to the Contractor. Display sample sections shall be provided for each type of pipe insulation used on the job, and for hot pipelines and cold pipelines both interior and exterior even when the same type of insulation is used for these services. Display sample sections shall include as a minimum an elbow or tee, a valve, a hanger with protection shield and insulation insert at support point, method of fastening and sealing insulation at longitudinal lap, circumferential lap, butt joints at fittings and on pipe runs, and termination points. Each material that is used to make up the insulation system shall be identified by indicating on an attached sheet first the specification requirement for the material and then the material by manufacturer that is intended to meet the requirement.

5. MATERIALS shall conform to the following requirements.

5.1 Adhesives: Mil. Spec. MIL-A-3316, Class 1 or 2 as specified.

5.2 Contact Adhesive: Mil. Spec. MIL-A-24179, Type II, Class 1.

5.3 Bands On Aluminum Jacket: 3/8-inch by 0.020-inch and 2-inch by 0.016-inch thick aluminum.

5.4 Bedding Compound: Mil. Spec. MIL-B-19564.

5.5 Corner Angles: Minimum 28 gage, 1-inch by 1-inch aluminum adhered to 2-inch by 2-inch heavy kraft paper.

5.6 Mineral Fiber Thermal Insulating Cement: ASTM C 195.

5.7 Duct Insulation for Air Conditioning Duct: Fed. Spec. HH-I-558, Form A, Class 2; Form B, Type I, Class 6 or 7. Density shall conform to requirements specified hereinafter.

5.8 Equipment Insulation, Cold Equipment (Below 60 Degrees F.):

5.8.1 Cellular Glass: Fed. Spec. HH-I-551.

5.8.2 Mineral Fiber: Fed. Spec. HH-I-558 Form A, Class 2, minimum density 3 pcf.

5.9 Equipment Insulation, Hot Equipment (Above 60 Degrees F.):

5.9.1 Cellular Glass (Up to 250 Degrees F. Service): Fed. Spec. HH-I-551, Type I, or ASTM C 552, Type III.

5.9.2 Calcium Silicate (Up to 1,200 Degrees F. Service): ASTM C 533, Type I, pipe shape may be used on diesel engine exhaust piping and mufflers. Material shall meet the requirements of Mil. Spec. MIL-I-24244 for use on stainless steel surfaces.

5.9.3 Mineral Fiber (Up to 1,800 Degrees F. Service): Fed. Spec. HH-I-558, Form A, Class 2, 3, 4, or 5 as required for temperature encountered, minimum density 3 pcf.

5.10 Glass Tape: Mil. Spec. MIL-C-20079, Type II, Class 1 or 3. Tape shall be 4-inch wide rolls. Class 3 shall be 4.5 ounces per square yard.

5.11 Insulation Jackets:

5.11.1 Vapor Barrier Jackets: Vapor barrier jackets used on insulation exposed in finished areas shall have white finish suitable for painting without sizing.

5.11.1.1 Vapor Barrier Jacket for Pipe and Equipment: Fed. Spec. HH-B-100, Type I. Factory composite materials may be used to meet Beech puncture units.

5.11.1.2 Vapor Barrier Jacket for Air-Conditioning Duct: Fed. Spec. HH-B-100, Type I for duct in equipment room and exposed areas and Type I or Type II in all other areas. Factory composite materials may be used to meet Beech puncture units.

5.11.2 Aluminum Jacket: Corrugated, embossed or smooth sheet, 0.016-inch nominal thickness; ASTM B 209, Temper H14, Temper H16, Type 3003, 5005, 3105 or 5010. Jackets shall be provided with moisture barrier except when applied over vapor barrier jackets. Corrugations may run longitudinally or circumferentially.

5.12 Staples: Outward clinching type, galvanized.

5.13 Pipe Insulation for Cold Pipelines (Minus 30 Degrees to Plus 60 Degrees F., and Domestic Cold Water, Dual Temperature Pipe, and Interior Roof Drains):

5.13.1 Cellular Glass: ASTM C 552, Type II, Class 1.

5.13.2 Mineral Fiber: Fed. Spec. HH-I-558, Form D, Type III, Class 12.

5.13.3 Phenolic Foam: Continuous molded rigid pipe insulation made from an essentially chemically neutral phenolic foam. Service temperature range of minus 40 degrees F. to 250 degrees F. thickness shall be as required for mineral fiber.

Pipe Insulation for Hot Pipelines (Above 60 Degrees F.):

5.14.1 Calcium Silicate: ASTM C 533, Type I.

5.14.2 Glass, Cellular: ASTM C 552, Type II, Class 1.

5.14.3 Mineral Fiber: Fed. Spec. HH-I-558, Form D, Type III, Class 12.

5.14.4 Phenolic Foam: Continuous molded rigid pipe insulation made from an essentially chemically neutral phenolic foam. Service temperature range of minus 40 degrees F. to 250 degrees F. thicknesses shall be as required for mineral fiber.

5.15 Polyvinyl Chloride Fitting Covers: Fed. Spec. L-P-535, Composition A, Type II.

5.16 Flexible Unicellular Insulation: Fed. Spec. HH-I-573.

5.17 Vapor Barrier Coating: Mil. Spec. MIL-C-19565, Type II. Color shall be white and qualification for listing is not required.

Wire: Soft annealed galvanized wire, 16 gage.

6. INSTALLATION: Except as specified, material shall be installed in accordance with the recommendations of the manufacturer. Insulation materials shall not be applied until tests specified in other sections of these specifications are completed; foreign material such as rust, scale, or dirt has been removed from surfaces to receive insulation; and the surfaces are clean and dry. Insulation shall be kept clean and dry at all times.

7. INSULATION AND VAPOR BARRIER FOR AIR CONDITIONING DUCT AND WARM AIR DUCT:

7.1 General:

7.1.1 Ducts and associated equipment insulation thicknesses shall be as follows:

|                                  |       |
|----------------------------------|-------|
| a. Duct-mounted coil casings     | 2     |
| b. Coil headers and return bends | 2     |
| c. Fresh air intake ducts        | 1-1/2 |

- d. Supply fans (field-insulated) 2
- e. Site-erected air condition casings 2
- f. Ducts exposed to weather 2

7.1.2 Ducts not requiring insulation are as follows:

- a. Factory fabricated double wall internally insulated duct.
- b. Glass fiber duct.
- c. Site-erected air conditioning casings and plenums constructed of factory-insulated sheet metal panels.
- d. Supply and return ducts in air conditioned spaces unless otherwise shown. Air conditioned spaces shall be defined as those spaces directly supplied with conditioned air, or provided with a cooling device such as a fan-coil unit.
- e. Factory preinsulated flexible ducts.

7.1.3 Insulation for rectangular ducts shall be flexible type where concealed, minimum density 3/4 pcf and rigid type where exposed, minimum density 3 pcf. Insulation for round ducts shall be flexible type, minimum density 3/4 pcf. Insulation for exposed ducts shall be provided with either a factory applied vapor barrier jacket or a vapor barrier coating finish as specified. Insulation on concealed duct shall be provided with a factory-applied vapor barrier jacket.

7.1.4 Vapor barrier coating finish shall be accomplished by applying two coats of Type II vapor barrier coating with a layer of glass cloth embedded between the coats. The total dry film thickness shall be approximately 1/16 inch.

## 7.2 Application:

7.2.1 General Requirements: Duct insulation shall be continuous through sleeves and prepared openings. Duct insulation shall terminate at fire dampers and flexible connections. Vapor barrier materials shall be applied to form a complete unbroken vapor seal over the insulation.

### 7.2.2 Installation on Exposed Duct Work:

7.2.2.1 For rectangular ducts, rigid insulation shall be secured to the duct by mechanical fasteners on all four sides of the duct, spaced not more than 12 inches apart and not more than 3 inches from the edges of the insulation joints. A minimum of two rows of fasteners shall be provided for each side of duct 12 inches and larger. One row shall be provided for each side of duct less than 12 inches.

7.2.2.2 Duct insulation shall be formed with minimum jacket seams, and in no case shall a jacket seam be allowed on or within 3 inches of the duct corner. Insulation shall be brought up to standing seams, reinforcing, and

other vertical projections and shall not be carried over. Vapor barrier jacket shall be continuous across seams, reinforcing, and projections. When height of projections is greater than the insulation thickness, insulation and jacket shall be carried over.

7.2.2.3 Insulation shall be impaled on the fasteners; speed washers shall be installed and pin trimmed to washer.

7.2.2.4 Joints in the insulation jacket shall be sealed with a 4-inch wide strip of the same material as the vapor barrier jacket. The strip shall be secured with Class 2 adhesive and stapled.

7.2.2.5 Staples and seams shall be sealed with a brush coat of Type II vapor barrier coating.

7.2.2.6 Breaks and ribs or standing seam penetrations in the jacket material shall be covered with a patch of the same material as the jacket. Patches shall extend not less than 2 inches beyond the break or penetration and shall be secured with Class 2 adhesive and stapled. Staples and joints shall be sealed with a brush coat of vapor barrier coating.

7.2.2.7 At jacket penetrations such as hangers, thermometers, and damper operating rods, the voids in the insulation shall be filled with vapor barrier coating and the penetrations sealed with a brush coat of vapor barrier coating.

7.2.2.8 Insulation terminations and pin punctures shall be sealed and flashed with a reinforced vapor barrier coating. Two coats of Type II vapor barrier coating shall be applied with glass cloth embedded between coats. The coating shall have a dry film thickness of approximately 1/16 inch and shall overlap the adjoining insulation and uninsulated surface 2 inches.

7.2.3 Exposed Ductwork Without a Factory Applied Insulation Jacket: Whenever a factory applied vapor barrier jacket is not furnished, a vapor barrier coating finish shall be applied to the entire surface by first applying corner angles to exposed corners and then applying two coats of vapor barrier coating with glass cloth embedded between coats. Coating thickness shall be approximately 1/16 inch.

## 8. DUCT AND EQUIPMENT EXPOSED TO WEATHER:

8.1 Installation: Ducts and equipment exposed to weather shall be insulated and finished as specified for the applicable service for exposed duct and equipment inside the building. After the above is accomplished, the insulation shall then be further finished.

### 8.2 Finish:

8.2.1 Rectangular Ducts and Equipment: Corner angles shall be applied to exposed corners of the insulation. Two coats of weatherproof mastic as recommended by insulation manufacturer shall be applied to the entire surface with a layer of glass cloth embedded between coats. Glass cloth

overlaps at joints and adjoining surfaces shall be not less than 2 inches. Each coat of weatherproof coating shall be 1/16-inch minimum thickness.

8.2.2 Optional Panels: At the option of the Contractor, prefabricated metal insulation panels may be used in lieu of the insulation and finish previously specified. Thermal performance shall be equal to or better than that specified for applied insulation. Panels shall be the standard catalog product of a manufacturer of metal insulation panels. Fastenings, flashing, and support system shall conform to published recommendations of the manufacturer for a weatherproof installation that will prevent moisture from entering the insulation. Panels shall be designed to accommodate thermal expansion and to support a 250 pound walking load without permanent deformation or permanent damage to the insulation. Exterior metal cover sheet shall be aluminum and exposed fastenings shall be stainless steel or aluminum.

#### 9. INSULATION FOR COLD EQUIPMENT (BELOW 60 DEGREES F.):

9.1 General Requirements: Insulation shall be rigid block, or semirigid board, suitable for the temperature encountered. Cold equipment shall include pumps handling media below 60 degrees F., expansion tanks, air separation tanks, drain pans, parts of air handling units, condensing units, duct mounted coils, and other equipment. Thicknesses shall be as follows:

- a. Equipment handling media between 35 degrees F. and 60 degrees F.: 1-1/2 inch thick mineral fiber or 2-inch thick cellular glass.
- b. Equipment handling media between 0 degree F. and 34 degrees F.: 2-1/2 inch thick mineral fiber or 3-1/2 inch thick cellular glass.
- c. Equipment handling media between minus 30 degrees F. and minus 1 degree F.: 3-inch thick mineral fiber or 4-inch thick cellular glass.

#### 9.2 Insulation and Finish on Cold Equipment:

9.2.1 Insulation shall be formed or fabricated to fit the equipment. To insure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

9.2.2 Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not more than 12-inch centers. Insulation corners shall be protected under wires and bands with suitable corner angles.

9.2.3 Cellular glass insulation shall be set in a coating of bedding compound, and joints shall be sealed with bedding compound. Mineral fiber insulation joints shall be filled with insulating cement.

#### 10. INSULATION FOR HOT EQUIPMENT (ABOVE 60 DEGREES F.):

10.1 General Requirements: Insulation shall be rigid block or semirigid board suitable for the temperature encountered. Hot equipment shall include hot water generators, water heaters, pumps handling media above 130 degrees F., hot water storage tanks, air separation tanks, unjacketed

boilers or parts of boilers, boiler flue gas connection from boiler to stack, and other equipment. Insulation thicknesses for equipment handling steam to 15 psig or other media to 250 degrees F. shall be 2-inch thick material.

## 10.2 Insulation and Finish on Hot Equipment:

10.2.1 Insulation of Pump: Pumps shall be insulated by forming a box around the pump housing. The box shall be constructed by forming the bottom and sides using joints which do not leave raw ends of insulation exposed. Bottom and sides shall be banded to form a rigid housing which does not rest on the pump. Joints between top cover and sides shall fit tightly. The joint forming a female shiplap joint on the side pieces and a male joint on the top cover, thus making the top cover removable. The entire surface of the removable section shall be finished as specified.

### 10.2.2 Other Equipment:

10.2.2.1 Insulation shall be formed or fabricated to fit the equipment. To insure a tight fit on round equipment, edges shall be beveled and joints shall be tightly butted and staggered.

10.2.2.2 Insulation shall be secured in place with bands or wires at intervals as recommended by the manufacturer but not greater than 12-inch centers. Insulation corners shall be protected under wires and bands with suitable corner angles.

10.2.3 Smoothing coat of insulating cement shall be applied over insulation, except for removable sections of insulation.

10.2.4 Upon completion of installation of insulation, two coats of Class 1 adhesive with glass cloth embedded between the coats shall be applied. The dry film thickness of the finish shall be 1/16 inch.

## 11. ABOVEGROUND PIPE INSULATION:

11.1 General Requirements: Except as specified or shown otherwise, aboveground domestic hot water, condensate and hot water heating pipelines inside the structure shall be insulated as specified for hot pipelines. Domestic cold and chilled drinking water piping, refrigerant suction lines, air conditioner condensate drain pipelines shall be insulated as specified for cold pipelines; exterior piping shall be insulated as specified for piping exposed to weather. The following lines shall not be insulated:

- a. Pipe used solely for fire protection.
- b. Chromium-plated pipe to plumbing fixtures.
- c. Vertical portions of interior roof drain pipelines.

### 11.2 Pipes Passing Through Sleeves:

11.2.1 Pipe insulation shall be continuous through the sleeve.

11.2.2 An aluminum jacket shall be provided over the insulation wherever calking is required.

11.2.3 Where penetrating interior walls, the aluminum jacket shall extend 2 inches beyond either side of the wall and shall be secured on each end with a band.

11.2.4 Where penetrating floors, the aluminum jacket shall extend from a point below the backup material to a point 10 inches above the floor with one band at the floor and one not more than 1 inch from the end of the aluminum jacket.

11.2.5 Where penetrating waterproofed floors, the aluminum jacket shall extend from below the backup material to a point 2 inches above the flashing with a band 1 inch from the end of the aluminum jacket.

11.2.6 Where penetrating exterior walls, the aluminum jacket required for pipe exposed to weather shall continue through the sleeve to a point 2 inches beyond the interior surface of the wall.

11.2.7 Where penetrating roofs, pipe shall be insulated as required for interior service to a point flush with the top of the flashing and sealed with vapor barrier coating. The insulation for exterior application shall butt tightly to the top of flashing and interior insulation. The exterior aluminum jacket shall extend 2 inches down beyond the end of the insulation to form a counter flashing. The flashing and counter flashing shall be sealed underneath with Type II vapor barrier coating.

### 11.3 Pipes Passing Through Hangers:

11.3.1 Insulation, whether hot or cold application, shall be continuous through hangers.

11.3.2 Support points such as hangers or rollers shall have a galvanized protection shield conforming to MSS SP-69, Type 40.

11.3.3 On pipes 2 inches and larger, an insulation insert of a density at least 9 pcf shall be installed under the hanger. The insert shall be the same length as the protection shield and shall cover not less than the bottom 180 degree arc of the pipe. As an option, at least three wood or cork dowels may be used and placed strategically between the pipe and shield on an approximate 180 degree arc. Inserts, blocks, or dowels shall be the same thickness as the insulation.

11.3.4 Inserts, blocks, or dowels shall be covered with a jacket material of the same appearance and quality as the adjoining pipe insulation jacket, shall overlap the adjoining pipe jacket 1-1/2 inches, and shall be sealed as required for the pipe jacket.

11.3.5 A factory fabricated protection shield unit that complies with the requirements specified for individual components may be furnished.

11.4 Cold Pipelines (Minus 30 Degrees to 60 Degrees F., Domestic Cold Water, Dual Temperature Pipe, and Interior Roof Drains):

11.4.1 Insulation Thickness: Thickness of insulation shall be as indicated in Table I.

11.4.2 Vapor Barrier Jacket: Pipe insulation shall be covered with a factory applied vapor barrier jacket. Insulation or phenolic foam inside the building shown to be protected with an aluminum jacket shall have the insulation and vapor barrier jacket installed as specified herein. The aluminum jacket shall be installed as specified for piping exposed to weather, except sealing of the laps of the aluminum jacket is not required.

11.4.3 Cold Pipe Insulation (Straight Runs):

11.4.3.1 Insulation shall be applied to the pipe with joints tightly butted and the ends of the insulation sealed off with Type II vapor barrier coating at intervals not to exceed 15 feet.

11.4.3.2 Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches. Butt strips 3 inches wide shall be provided for circumferential joints.

11.4.3.3 All laps and butt strips shall be secured with Class 2 adhesive and stapled on 4-inch centers.

11.4.3.4 Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F. The lap system shall be installed in accordance with manufacturer's recommendations. Stapler shall be used only if specifically recommended by the manufacturer. Where fishmouths occur, the section shall be replaced or the fishmouth repaired by applying Class 2 adhesive under the lap and then stapling.

11.4.3.5 Staples and seams, including those on self-sealing lap systems shall be coated with a Type II vapor barrier coating.

11.4.3.6 Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and securing it with adhesive, stapling, and coating as specified for butt strips. The patch shall extend not less than 1-1/2 inches past the break.

11.4.3.7 At penetrations such as thermometers, the void in the insulation shall be filled with vapor barrier coating and the penetration shall be sealed with a brush coat of the same coating.

11.4.3.8 Gage piping may be insulated with unicellular plastic insulation.

11.4.4 Insulation for Flanges, Unions, Valves, Anchors, Fittings, and Accessories:

11.4.4.1 Pipe insulation shall have ends thoroughly coated with Type II vapor barrier coating not more than 6 inches from each flange, union, valve, anchor, or fitting in all directions.

11.4.4.2 Insulation of the same thickness and conductivity as the adjoining pipe insulation (either premolded or segmented) shall be placed

around the item, abutting the adjoining pipe insulation. If nesting size insulation is used, the insulation should be overlapped 2 inches or one pipe diameter. Loose fill mineral wool or insulating cement shall be used to fill the voids. Elbows insulated using segments shall not have less than 3 segments per elbow. Insulation may be secured by wire or tape until finish is applied.

11.4.4.3 Upon completion of installation of insulation two coats of Type II vapor barrier coating shall be applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. The coating shall extend out onto the adjoining pipe insulation 2 inches.

11.4.4.4 Where unions are shown not to be insulated, the insulation shall be tapered to the union at a 45-degree angle. The insulation and jacket shall terminate and shall be sealed with two coats of Type II vapor barrier coating with glass tape embedded between coats.

11.4.4.5 Anchors attached directly to the pipe shall be insulated for a sufficient distance to prevent condensation but not less than 6 inches from the insulation surface.

11.4.4.6 Flexible connections at pumps and other equipment shall be insulated with unicellular plastic insulation, unless otherwise indicated.

11.4.5 Optional Poly-Vinyl Chloride Fitting Covers: At the option of the Contractor, premolded, one-piece polyvinyl chloride (PVC) fitting covers may be used in lieu of the embedded glass tape. Factory premolded insulation or field-fabricated insulation segments shall be used under the fitting covers. Blanket inserts will not be allowed. Insulation shall be covered with 2 or more coats of Type II vapor barrier coating to a minimum thickness of 1/16 inch before the PVC covers are installed. The covers shall be secured by PVC vapor barrier tape or with tacks made for securing PVC covers. All tape seams and tacks shall then be coated with Type II vapor barrier coating. Premolded PVC fitting covers shall not be used where exposed to the weather.

## 11.5 Hot Pipelines (Above 60 Degrees F.):

11.5.1 Insulation Thickness: Pipelines shall be covered with insulation. Insulation thickness shall be determined using the manufacturer's published thermal conductivity k, and the applicable Table II or Table III attached to this section. Insulation thickness for pipelines handling 60 degrees F. to 200 degrees F. hot water shall be as indicated in Table IV attached to this section.

11.5.2 Vapor Barrier Jacket: Pipe insulation shall be covered with a factory applied vapor barrier jacket. Insulation shown to be protected with aluminum jacketing shall be provided with factory applied vapor barrier jacket and covered with field-applied or approved factory-applied type aluminum jacket.

## 11.5.3 Hot Pipe Insulation:

11.5.3.1 Insulation shall be applied to the pipe with joints tightly butted.

11.5.3.2 Longitudinal laps of the jacket material shall overlap not less than 1-1/2 inches, and butt strips 3 inches wide shall be provided for circumferential joints.

11.5.3.3 Laps and butt strips shall be secured with Class 2 adhesive and stapled on 4-inch centers. Adhesive may be omitted where pipe is concealed.

11.5.3.4 Factory self-sealing lap systems may be used when the ambient temperature is between 40 degrees and 120 degrees F. and shall be installed in accordance with manufacturers instructions. Laps and butt strips shall be stapled whenever there is nonadhesion of the system. Where fishmouths occur, the section shall be replaced or the fishmouth repaired by applying Class 2 adhesive under the lap and then stapling.

11.5.3.5 Breaks and punctures in the jacket material shall be patched by wrapping a strip of jacket material around the pipe and cementing, stapling, and coating as noted for butt strips. Patch shall extend not less than 1-1/2 inches past the break.

11.5.4 Insulation on Flanges, Unions, Valves, Anchors, Fittings, and Accessories:

11.5.4.1 The run of the line pipe insulation shall have the ends brought up to the item.

11.5.4.2 Insulation of the same thickness and conductivity as the adjoining pipe insulation, either premolded or segmented, shall be placed around the item abutting the adjoining pipe insulation, or if nesting size insulation is used, overlapping 2 inches or one pipe diameter. Loose fill mineral wool or insulating cement shall be used to fill the voids. Elbows insulated using segments shall have not less than 3 segments per elbow. Insulation may be wired or taped on until finish is applied.

11.5.4.3 Upon completion of installation of insulation, two coats of Class 1 adhesive shall be applied with glass tape embedded between coats. Tape seams shall overlap 1 inch. Coating shall extend onto the adjoining insulation not less than 2 inches. The total dry film thickness shall be not less than 1/16 inch.

11.5.4.4 Where unions are shown not to be insulated, the insulation shall be tapered to the union at a 45-degree angle. The insulation and jacket shall terminate and shall be coated with two coats of Class 1 adhesive with glass tape embedded between coats. The total dry film thickness shall be not less than 1/16 inch.

11.5.5 Optional Poly-Vinyl Chloride Fitting Covers: At the option of the Contractor, factory premolded one-piece PVC fitting covers may be used in lieu of the two coats of adhesive with tape embedded between coats. Insulation for flanges, unions, valves, anchors, fittings, and accessories, with factory premolded insulation fitting covers shall be installed as specified for field fabricated segments. Factory premolded one-piece PVC fitting cover shall be installed over the insulation and secured by stapling, taping with PVC vapor barrier tape, or with metal or plastic

tacks made for securing PVC fitting covers. PVC fitting covers shall not be used where exposed to the weather.

11.6 Piping Exposed to Weather: Piping exposed to weather shall be insulated and jacketed as specified for the applicable service, prior to application of the aluminum jacket.

11.6.1 An aluminum jacket shall be installed over the insulation. The jacket for hot piping may be factory applied. The jacket shall overlap not less than 2 inches at longitudinal and circumferential joints and shall be secured with bands at not more than 12-inch centers. Longitudinal joints shall be overlapped down to shed water. Circumferential joints shall be sealed with a coating recommended by the insulation manufacturer for weatherproofing seams and joints in aluminum jackets.

11.6.2 Flanges, unions, valves, fittings, and accessories shall be insulated and finished as specified for the applicable service. Two coats of an emulsion type weatherproof mastic recommended by the insulation manufacturer shall be applied with glass tape embedded between coats. Tape overlaps shall be not less than 1 inch and the adjoining aluminum jacket not less than 2 inches. Factory preformed aluminum jackets may be used in lieu of the above.

## 12. UNICELLULAR PLASTIC INSULATION:

12.1 General: Unicellular plastic insulation may be substituted for aboveground insulation for all services up to and including 200 degrees F. for piping and from 35 to 60 degrees F. for equipment.

12.2 Insulation Thickness for Pipe: Insulation thickness for pipe shall be as indicated in Table V.

12.3 Insulation Thickness for Equipment: Insulation thickness for equipment handling media between 35 degrees F. and 60 degrees F.: 1-1/2 inch.

### 12.4 Installation of Pipe Insulation:

12.4.1 Pipes, 5 inches and less shall be insulated with tubular sections, and pipes over 5 inches shall be insulated with field or factory precut sheets.

12.4.2 Insulation shall be continuous through sleeves. Aluminum jacket shall be provided over the insulation at sleeves where calking is required. The aluminum jacket shall be installed as specified for pipe insulation.

12.4.3 Insulation shall be continuous through hangers and shall be provided with a metal protection shield with inserts, wood or cork dowels, or blocks as specified previously. Rigid inserts shall be bonded to the adjoining insulation with contact adhesive.

12.4.4 At the option of the Contractor, a factory fabricated protection shield unit that meets the requirements for the component parts may be used.

12.4.5 Bent pipe and tubing shall be insulated by slipping the tubular insulation section over the pipe prior to joining. Straight pipe, 5 inches or less, shall have the insulation slipped over or slit and installed. Sheets cut to proper size and wrapped shall be used for pipe larger than 5 inches. Seams and butt joints shall be sealed with contact adhesive.

12.4.6 Flanges, couplings, unions, valves, anchors, and fittings shall be insulated with field fabricated sections of insulation of the same thickness as the adjoining insulation. Nesting size sections shall overlap the adjoining sections not less than 1 inch, and all seams, joints and overlaps shall be sealed with contact adhesive. Anchors shall be insulated for a sufficient distance to prevent condensation but in no case shall the distance be less than 6 inches away from the pipe surface.

12.4.7 Ends of insulation at termination points shall be sealed to the pipe with a brush coat of Type II vapor barrier coating. Where insulation abuts other types of insulation, the jacket or finish for other insulation shall be sealed vapor tight to the surface of the unicellular insulation.

12.5 Installation of Insulation on Equipment: Unicellular plastic insulation on equipment shall be installed as follows: Seams and joints shall be sealed with contact adhesive. Termination points shall be sealed; and joints with other types of insulation materials shall be made as specified for piping.

12.6 Finish: No additional finish is required inside the building, except that where shown insulation shall be protected with field applied aluminum jacket. Insulation exposed to weather not shown to have aluminum jacket shall be protected against ultraviolet deterioration with two coats of finish recommended by the manufacturer after the adhesive is thoroughly dry. At the option of the Contractor, high-impact ultraviolet resistant PVC plastic may be used in lieu of the aluminum jacket. Plastic jacketing shall be designed by the manufacturer especially for protection of pipe insulation, and shall be at least 0.030 inches thick. Installation shall be in accordance with the recommendations of the manufacturer and shall include provisions for thermal expansion.

13. PAINTING AND FINISHING: Painting shall be as specified in SECTION: PAINTING, GENERAL.

TABLE I.  
Pipe Size (Inches)

| Service or Range<br>of Temp (Degrees<br>F.) |      | 1/4 to<br>1-1/4 | 1-1/2<br>to 3 | 3-1/2<br>to 5 | 6 to<br>10 | 11 to<br>24 | 25 to<br>33 |
|---|------|-----------------|---------------|---------------|------------|-------------|-------------|
| 60 to 35                                    | (CG) | 1-1/2           | 1-1/2         | 2             | 2          | 2           | 2           |
|   | (MF) | 1               | 1             | 1-1/2         | 1-1/2      | 1-1/2       | 1-1/2       |
| 34 to 0                                     | (CG) | 2-1/2           | 2-1/2         | 2-1/2         | 3          | 3           | 3-1/2       |
|   | (MF) | 1-1/2           | 1-1/2         | 2             | 2          | 2-1/2       | 2-1/2       |
| -1 to -30                                   | (CG) | 3               | 3             | 3             | 3-1/2      | 3-1/2       | 4           |
|   | (MF) | 1-1/2           | 2             | 2-1/2         | 2-1/2      | 3           | 3           |
| Domestic<br>Cold Water                      | (CG) | 1               | 1             | 1             | 1-1/2      | 1-1/2       | 1-1/2       |
|   | (MF) | 1/2             | 1/2           | 1/2           | 1          | 1           | 1           |

NOTES: CG - Cellular Glass  
MF - Mineral Fiber

TABLE II.

REQUIRED THICKNESS (IN INCHES) OF PIPE INSULATION FOR  
HANDLING STEAM TO 15 PSIG AND OTHER MEDIA TO 250 DEGREES F.

k = thermal conductivity (average) Btu/hr. sq. ft. degree/in.  
thickness at a mean temperature of 75 degrees F.

| Thermal<br>conductivity<br>k | Pipe<br>Size,<br>Inches<br>2 or less | Pipe Size,<br>Inches<br>2-1/2 to 3 | Pipe<br>Size,<br>Inches<br>4 | Pipe<br>Size,<br>Inches<br>5 to 6 | Pipe<br>Size,<br>Inches<br>8 | Pipe<br>size,<br>Inches<br>10 | Pipe<br>Size,<br>Inches<br>12 |
|------------------------------|--------------------------------------|------------------------------------|------------------------------|-----------------------------------|------------------------------|-------------------------------|-------------------------------|
| 0.25                         | 1.5                                  | 1.5                                | 2.0                          | 2.0                               | 2.0                          | 2.0                           | 2.5                           |
| 0.30                         | 1.5                                  | 1.5                                | 2.5                          | 2.5                               | 2.5                          | 2.5                           | 3.0                           |
| 0.35                         | 2.0                                  | 2.0                                | 2.5                          | 2.5                               | 2.5                          | 2.5                           | 3.5                           |
| 0.40                         | 2.0                                  | 2.5                                | 3.0                          | 3.0                               | 3.0                          | 3.0                           | 4.0                           |
| 0.45                         | 2.5                                  | 2.5                                | 3.0                          | 3.0                               | 3.5                          | 3.5                           | 4.0                           |

TABLE III.

REQUIRED THICKNESS (IN INCHES) OF PIPE INSULATION FOR PIPES  
HANDLING STEAM TO 250 PSIG AND OTHER MEDIA TO 450 DEGREES F.

k = thermal conductivity (average) Btu/hr. sq. ft. degree/in.  
thickness at a mean temperature of 75 degrees F.

| Thermal<br>conductivity<br>k | Pipe<br>Size,<br>Inches<br>2 or less | Pipe Size,<br>Inches<br>2-1/2 to 3 | Pipe<br>Size,<br>Inches<br>4 | Pipe<br>Size,<br>Inches<br>5 to 6 | Pipe<br>Size,<br>Inches<br>8 | Pipe<br>Size,<br>Inches<br>10 | Pipe<br>Size,<br>Inches<br>12 |
|------------------------------|--------------------------------------|------------------------------------|------------------------------|-----------------------------------|------------------------------|-------------------------------|-------------------------------|
| 0.25                         | 2.0                                  | 2.5                                | 2.5                          | 3.5                               | 3.5                          | 3.5                           | 3.5                           |
| 0.30                         | 2.0                                  | 2.5                                | 2.5                          | 3.5                               | 3.5                          | 3.5                           | 3.5                           |
| 0.35                         | 2.0                                  | 3.0                                | 3.0                          | 3.5                               | 4.0                          | 4.0                           | 4.0                           |
| 0.40                         | 2.0                                  | 3.0                                | 3.0                          | 3.5                               | 4.0                          | 4.0                           | 4.0                           |
| 0.45                         | 2.5                                  | 3.0                                | 3.5                          | 4.0                               | 4.0                          | 4.0                           | 4.5                           |

TABLE IV.

REQUIRED THICKNESS (IN INCHES) OF PIPE INSULATION FOR PIPES  
HANDLING HOT WATER.

MF - Mineral Fiber or Phenolic Foam. CG-Cellular Glass.

| Range of<br>Service<br>(Degrees F.) | Pipe<br>Size,<br>Inches<br>2 or less | Pipe Size,<br>Inches<br>2-1/2 to 3 | Pipe<br>Size,<br>Inches<br>4 | Pipe<br>Size,<br>Inches<br>5 to 6 | Pipe<br>Size,<br>Inches<br>8 | Pipe<br>Size,<br>Inches<br>10 | Pipe<br>Size,<br>Inches<br>12 |
|-------------------------------------|--------------------------------------|------------------------------------|------------------------------|-----------------------------------|------------------------------|-------------------------------|-------------------------------|
| 60 to 200 (MF)                      | 1.0                                  | 1.0                                | 1.0                          | 1.0                               | 1.5                          | 1.5                           | 1.5                           |
| (CG)                                | 1.5                                  | 1.5                                | 1.5                          | 1.5                               | 2.0                          | 2.0                           | 2.0                           |

TABLE V  
Pipe Size (Inches)

| Service or<br>Range of Temp<br>(Degrees F.) | Runouts (1)<br>up to 2" | 1/4 to<br>1-1/4 | 1-1/2<br>to 3 | 3-1/2<br>to 5 | 6 to<br>10 | 11 to<br>30 |
|---|-------------------------|-----------------|---------------|---------------|------------|-------------|
| 200 to 60                                   | 1/2"                    | 1               | 1             | 1             | 1-1/2      | 1-1/2       |
| 60 to 35                                    | 1/2"                    | 1               | 1             | 1-1/2         | 1-1/2      | 1-1/2       |
| 34 to 0                                     |                         | 1-1/2           | 1-1/2         |               |            |             |
| -1 to -30                                   |                         | 1-1/2           |               |               |            |             |
| Domestic Cold<br>Water                      |                         | 1/2             | 1/2           | 1/2           | 1          | 1           |

(1) Runouts to terminal units not to exceed 12 feet in length